

ON SOME POINTS IN THE STRUCTURE OF THE LARVA
OF EPISCHURA LACUSTRIS Forbes.

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WITH PLATES XII AND XIII.

Epischura is a genus of copepods found only in America, its nearest European relative being *Heterocope*, and is remarkable for the very pronounced asymmetry of the abdomen. This is especially noticeable in the male of *Epischura lacustris* Forbes, in which not only is the abdomen twisted to the right, but certain of the segments have marked lateral projections which together form a complicated grasping organ.

Inasmuch as *Epischura* is a form peculiar to America, and yet with no nearly allied forms in this country, its larval history is a matter of considerable interest as being likely to throw some light on its relationship to other copepods.

Forbes ('91, "On some Lake Superior Entomostraca") says, "among the many hundreds of specimens which I have examined from the Great Lakes and from several of the smaller lakes of Illinois, Michigan, and Wisconsin, I have rarely seen an immature form." It is true that during the summer months, when one is most likely to make collections of entomostraca, larval forms of *Epischura* are very rare, although I have found them in certain localities in May and even in August. It is in the winter months, however, that they are found in the greatest numbers, especially in the month of March. I have collected from Green Lake a large amount of material illustrating the larval stages, and I hope, later, to make a fairly complete description of its development. The publication of the results will necessarily be long delayed because of the time consuming labor involved in making the extremely delicate dissections of these

minute forms. It has seemed best to me, on this account, to publish certain facts which have already been worked out, although this paper must be considered as a communication preliminary to a more extended paper.

The peculiar armature of the furca, which can be recognized quite easily in all except the earliest stages, makes it possible to distinguish quite readily between the larval forms of *Epischura* and those of other copepods. The characteristic form of the first maxillipede is developed very early, and by this feature alone one can frequently pick out *Epischura* larvae with a considerable degree of accuracy.

In this paper I will treat of only two structures, the male abdomen, and the male fifth feet.

The dissections on which the following facts are based were made by Mr. E. E. Hemingway, under my direction, and much credit is due him for the skill which he acquired in distinguishing the larvae of *Epischura* from those of other copepods, and for the patience which he exercised in making the difficult dissections.

THE MALE ABDOMEN.

In the abdomen of the mature male the second and third segments are produced to the right, and from the fifth segment there are two projections to the right, one spatulate, and the other dentate. (Plate XII, Fig. 5.)

In the larval abdomen the segments of the abdomen retain their symmetry until the animal has reached very nearly the mature form. In plate XII, Figs. 1, 2, 3, and 4, are shown the 1, 3, 4, and 5 segment stages,—the last having the same number of segments as the mature animal. Up to and including the four segment stage there is nothing in the form of the segments to distinguish these larvae from the larvae of other copepods, as they are entirely symmetrical. In the last stage, however, the bend to the right is very marked: the projection on the second segment is much like that in the mature animal, and the same thing is true of the projections on the fifth segment: the third segment has a pronounced swelling on the right side, but is quite different from the form in the mature animal. The specimen from

which this figure was drawn could hardly be distinguished, in most respects, from one which had reached complete maturity. The asymmetry, then, seems to come in quite suddenly, and in the last stages of the development.

The furca of the mature *Epischura* is armed with three broad setae, an external spine, and a weak and inconspicuous internal seta. In the one segment stage, the three setae are much weaker, the internal seta is considerably longer, and there is, in addition, a lateral seta about midway of the length of the furca. The furca of *Epischura* in this stage differs very little from that of *Diaptomus* at the same degree of development. *Diaptomus* also has a lateral seta, but it is longer than that of *Epischura*, and is situated nearer the end of the furca. The lateral seta does not appear in the succeeding stages of *Epischura*, the armature in the three segment stage differing very little from that in the mature animal. In *Diaptomus* the six setae develop to nearly the same length and size, the lateral seta having moved down nearly to the end of the furca. In *Limnocalanus* the lateral seta remains upon the side of the furca, and the sixth, or internal seta is very weak. In *Epischura* the lateral seta disappears, the third, fourth, and fifth are largely developed, the second becomes a broad spine, and the sixth a short and weak seta. In *Cyclops* it is the third and fourth setae which are commonly the most highly developed, the second and fifth sometimes nearly equalling them, but in most cases being reduced to weak and short setae or spines.

DEVELOPMENT OF THE MALE FIFTH FOOT.

The fifth foot of *Epischura lacustris* consists of two parts, in which there is no clear evidence of the division into exopodite and endopodite. (Plate XIII, Fig. 5.) The right foot consists of two segments—the outer is triangular in shape, with a somewhat spatulate tip, and is always flexed upon the first segment. The left foot consists of three segments: the first has a long horn-shaped lateral process, which is as long as the other two segments; the second and third segments are concave on their inner margins; and the apical segment is armed with fine hairs upon the concave margin and with small spines at the tip.

The youngest specimen in which we have been able to obtain a male fifth foot was the one from which the abdomen was drawn for Fig. 2, Plate XII. This was in the three segment stage. The fifth feet are shown in Plate XIII, Fig. 1. In this figure as in Fig. 4, the feet were drawn from the side opposite to that from which the other figures were drawn, so that the relative position of the feet is reversed. In this figure it will be noticed that the left foot consists of a basal segment, and both an exopodite and an endopodite, each consisting of a single segment. The right foot consists of a basal segment, a one-segmented exopodite, and a process on the basal segment which apparently represents an endopodite. The fifth feet shown in Plate XIII, Fig. 2, represent practically the same stage of development as that in the first figure, but in this the right foot has an evident endopodite.

Figure 3 represents the fifth feet of an individual in which the abdomen had reached the four segmented stage. The exopodite of the left foot in this specimen is composed of two segments, the outer segment having three spines, while only one was found in the lower stages. The endopodite is still of a single segment, but has grown long and slender. In the right foot the exopodite is divided into two segments, and the endopodite has disappeared.

In figure 4 is shown the fifth feet of the individual from which the abdomen in Plate XII, Fig. 4, was drawn. In the right foot the exopodite is reduced from two segments to one, has become triangular or conical in shape, and is strongly reflexed. In the left foot the exopodite has the concave inner margins seen in the mature animal, and the terminal segment is armed with spines and hairs much as in the last stage. The endopodite has become greatly curved and is clearly to become the "curved process" of the basal segment as described in the mature form.

It is evident, then, that the fifth feet of *Epischura lacustris* are to be explained morphologically in this way. Of the two segments of the right foot, the first is the basal segment, and the second is the reduced exopodite, the endopodite having disappeared, although existing in lower stages. In the left foot the

exopodite is represented by the two outer segments, while the curved process of the basal segment is the endopodite.

The fifth feet of *Temora* and *Hetercope* are in their structure very similar to *Epischura*, and it is probable that they should be explained in the same way.

In regard to the inferences to be drawn from the structure of the abdomen and fifth feet as to the family history of *Epischura*, it is, perhaps, not safe to say much until the other parts of the body have been more thoroughly worked over. There seems to be nothing especially significant in the structure of the fifth feet. It is true that there is a marked resemblance between the larval fifth feet of *Epischura* and those of *Diaptomus*, but it is no more than one would expect if they conform to the general type of structure in the copepod appendage.

The persistence of the three large furcal setae, even in the earlier stages, would seem to indicate a rather remote connection with *Diaptomus*. On the other hand, the fact that the asymmetry of the abdomen and the lateral processes of the abdominal segments appear only in the very last stages point very strongly to the probability that this most marked peculiarity of *Epischura* is a recent development, and that *Epischura* may be quite closely connected with forms having symmetrical abdomens.

Ripon, Wis., October, 1899.

EXPLANATION OF PLATES.

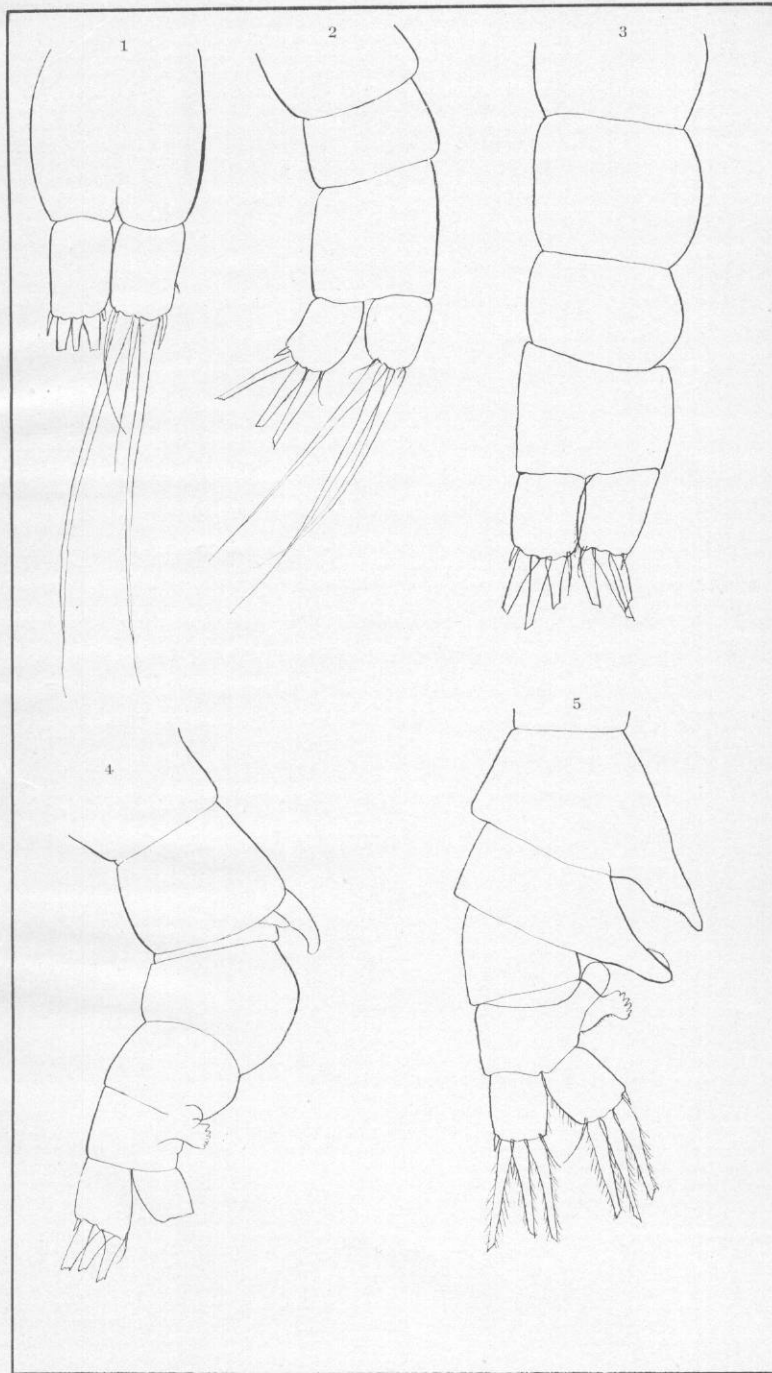
MARSH. *Epischura Lacustris*.

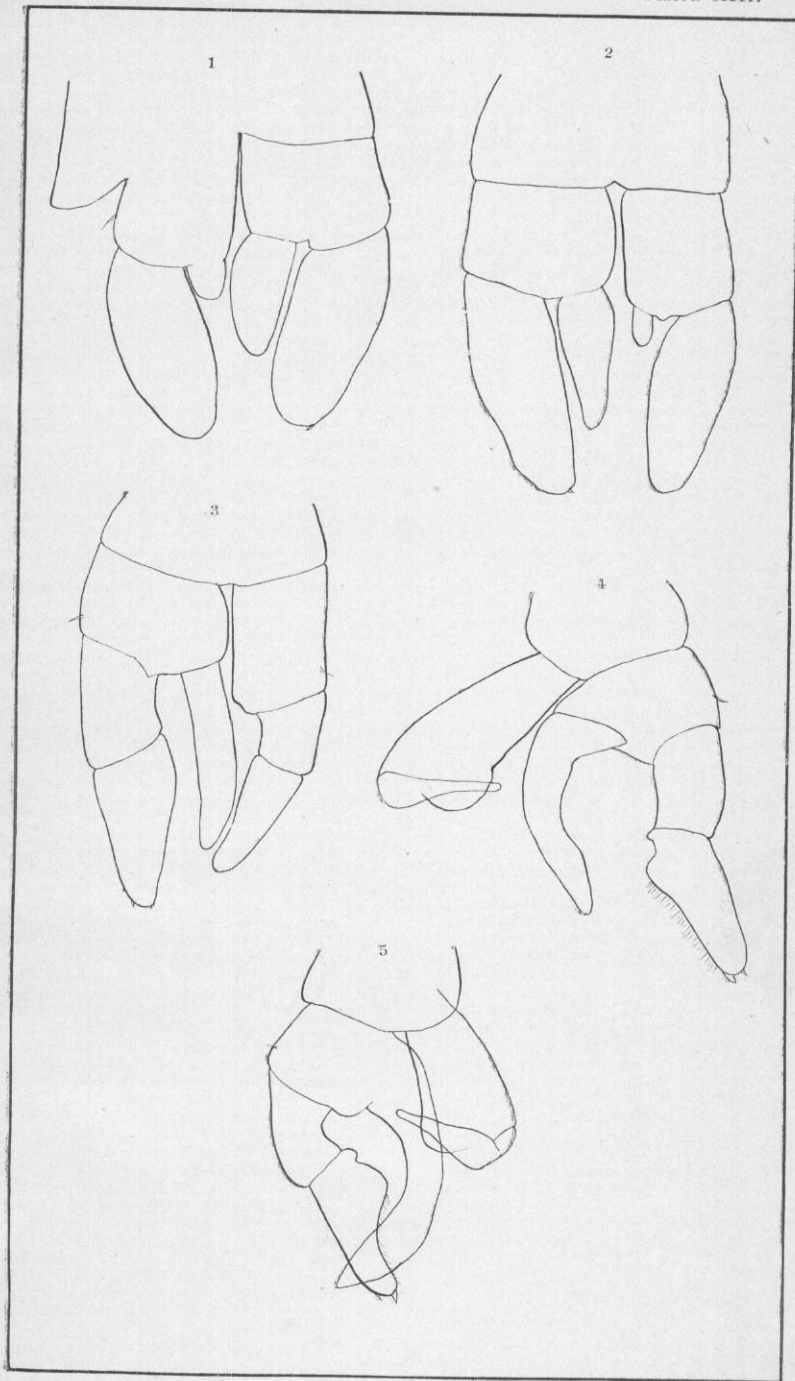
PLATE XII.

- Fig. 1—Abdomen of larva of male *Epischura Lacustris*, × 304.
Fig. 2—Abdomen of larva of male *Epischura Lacustris*, × 155.
Fig. 3—Abdomen of larva of male *Epischura Lacustris*, × 155.
Fig. 4—Abdomen of larva of male *Epischura Lacustris*, × 112.
Fig. 5—Abdomen of mature male *Epischura Lacustris*, × 112.

PLATE XIII.

- Fig. 1—Fifth feet of larva of male *Epischura Lacustris*, × 375.
Fig. 2—Fifth feet of larva of male *Epischura Lacustris*, × 375.
Fig. 3—Fifth feet of larva of male *Epischura Lacustris*, × 225.
Fig. 4—Fifth feet of larva of male *Epischura Lacustris*, × 140.
Fig. 5—Fifth feet of mature male *Epischura Lacustris*, × 140.





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With regards of the Author.

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